

**Claims:**

1. (Currently Amended) A process for the production of an hydrogenated polymer comprising the steps of:

~~providing an unsaturated polymer polymerizing monomer in an appropriate solvent to create a polymer cement in a polymerization reactor, wherein the polymer cement so produced includes unsaturated polymer;~~

~~removing the polymer cement from the polymerization reactor, wherein the polymer cement has a polymerization temperature above ambient temperature due to the heat of polymerization;~~

~~adding the polymer cement removed from the polymerization reactor into a hydrogenation reactor;~~

~~adding combining the unsaturated polymer with hydrogen gas and an hydrogenation catalyst solution into the polymer cement to create a reaction mixture, where the unsaturated polymer, hydrogen gas, and catalyst are dissolved in a solvent; and~~

~~pressurizing and heating the reaction mixture in the polymerization reactor such that the contents of the reaction mixture exist in the supercritical phase, thereby; and~~

~~hydrogenating said at least one unsaturated polymer while the contents of the reaction mixture are in the supercritical phase.~~

2. (Previously presented) A process for the hydrogenation of a polymer comprising the steps of:

determining the critical temperature and critical pressure for a mixture of hydrogen, at least one polymer, and at least one appropriate solvent for the at least one polymer wherein said step of determining includes process steps selected from the group consisting of:

(a)(i) mixing hydrogen and the at least one appropriate solvent at a given ratio,

(a)(ii) determining the critical point for the mixture of step (a)(i), and

(a)(iii) repeating said steps (a)(i) and (a)(ii) for a plurality of hydrogen to solvent ratios; and

(b)(i) dissolving the at least one polymer in the at least one appropriate solvent,

(b)(ii) adding hydrogen to a portion of the solution resulting in step (b)(i),

(b)(iii) determining the critical point for the mixture resulting in step (b)(ii), and

(b)(iv) repeating steps (b)(ii) and (b)(iii) for different weight fractions of hydrogen in the polymer solution of step (b)(i);

providing a polymer solution of the at least one polymer in the at least one appropriate solvent;

metering hydrogen gas and an hydrogenation catalyst solution into said polymer solution, to create a reaction mixture;

pressurizing and heating the reaction mixture to meet or exceed an appropriate critical pressure and critical temperature for the reaction mixture, as determined in said step of determining; and

hydrogenating the at least one polymer at or above the determined critical pressure and determined critical temperature.

3-4. (Cancelled)

5. (Currently amended) The process of claim 1, further comprising the step of determining the critical temperature and the critical pressure for ~~a mixture of the hydrogen, the unsaturated polymer at least one polymer, and the at least one appropriate solvent for the at least one polymer, wherein the critical temperature and critical pressure determined from this step are employed in said step of pressurizing and heating the reaction mixture in the polymerization reactor.~~

6. (Currently amended) The process of claim 5, wherein said step of determining includes process steps selected from the group consisting of:

(a)(i) mixing hydrogen and the at least one appropriate solvent at a given ratio,

- (a)(ii) determining the critical point for the mixture of step (a)(i), and
- (a)(iii) repeating said steps (a)(i) and (a)(ii) for a plurality of hydrogen to solvent ratios; and
- (b)(i) dissolving the ~~at least one~~ unsaturated polymer in the at least one appropriate solvent,
- (b)(ii) adding hydrogen to a portion of the solution resulting in step (b)(i),
- (b)(iii) determining the critical point for the mixture resulting in step (b)(ii), and
- (b)(iv) repeating steps (b)(ii) and (b)(iii) for different weight fractions of hydrogen in the polymer solution of step (b)(i).

7. (New) The process of claim 1, where the unsaturated polymer is selected from the group consisting of polybutadiene, polyisoprene, styrene butadiene rubber, styrene isoprene rubber, styrene butadiene styrene, styrene isoprene styrene, polydiclorobutadiene, polydimethylbutadiene, nitrile rubber, polychloroprene (neoprene), polyethylene oxide, methyl acrylate, methyl acrylate, silicone-based polymers, polyacrylamide, and polybutadiene (block) nylon.

8. (New) The process of claim 1, where the solvent is selected from the group consisting of normal and branched alkanes, cycloalkanes, alkenes, dienes, aromatics, alkyl substituted aromatics and carbon dioxide.

9. (New) The process of claim 1, where the catalyst is a hydrogenation catalyst.

10. (New) The process of claim 10, where the hydrogenation catalyst includes lithium, iron, cobalts, palladium, platinum, rhodium, ruthenium, osmium, iridium, or mixtures thereof.